The Effect of Keyboard Typing on the Median Nerve at the Proximal Carpal Tunnel

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\textbf{ABSTRACT}

The aim of this study was to investigate the changes in the median nerve cross-sectional area (MNCSA) before and after keyboard typing activity. Eight right-handed healthy male adults were recruited. The participants were required to rest for 30 minutes and then perform two 30-minute typing activities on a height-adjusted table and chair. The median nerve was examined by using the GE Healthcare Ultrasound System (Model LOGIQ e) at the proximal carpal tunnel level. The ultrasound examination was performed prior to resting, before typing and at the end of each typing session. Subsequently, using a tracing method on ImageJ, the MNCSA was quantified. The MNCSAs prior to resting, before typing, after 30-minutes of typing and after 60-minutes of typing were 9.6 ± 1.7 mm\textsuperscript{2}, 9.4 ± 1.8 mm\textsuperscript{2}, 10.7 ± 1.9 mm\textsuperscript{2}, and 10.2 ± 1.2 mm\textsuperscript{2}, respectively. The main effect of typing activity on changes to the MNCSA was significant (p < 0.05) as indicated by a one-way repeated ANOVA. This study demonstrated that the median nerve became larger after 30-minutes and 60-minutes of typing activity. Biomechanical factors, such as wrist-finger movements during typing activity, and typing duration could contribute to the acute swelling of the median nerve at the proximal carpal tunnel level.

Keywords: Carpal tunnel syndrome, Ultrasound imaging, Median nerve cross-sectional area

\textbf{1. Introduction}

Work-related musculoskeletal disorders, such as carpal tunnel syndrome (CTS), often lead to disabilities among workers (Bureau of Labor Statistics, 2008; Daniell et al., 2005; Foley et al., 2007). CTS is a peripheral neuropathy due to compression on the median nerve at the carpal tunnel. Repetitive joint movements and joint position are the main biomechanical factors that may influence CTS. Moreover, studies suggested occupational biomechanical factors may contribute to workplace CTS incidents (Bao et al., 2015; Dias et al., 2004; Harris-Adamson et al., 2015).

Wrist angle changes are known to cause compression stress on the median nerve and lead to deformation of the median nerve at the carpal tunnel region (Loh & Muraki, 2014; Loh & Muraki, 2015; Loh et al., 2015; Wang et al., 2014). In addition, finger movement also causes deformation of the median nerve, due to the compression from the surrounding soft tissues and the finger flexor tendon (Korstanje et al., 2010; Kursa et al., 2006; Loh et al., 2016a; Loh et al., 2016b; Ugboh et al., 2005).

In contrast, the kinematics of the wrist and digits during typing may not only induce muscle fatigue, but may also associate with CTS incidents among computer users (Baker, 2013; Baker et al., 2007; Rainoldi et al., 2008). Typing on a keyboard involves repetitive finger flexion-extension movements that may cause compression stress to the median nerve within the carpal tunnel region. Carpal tunnel pressure is known to change with different wrist postures, finger movements, and contact stress on the volar wrist, and can lead to an increase in carpal tunnel pressure (Keir et al., 1998; Keir et al., 1997; Rempel et al., 1997).

Additionally, repetitive finger movements could result in a higher shear strain between the median nerve and the sub synovial connective tissue (Kursa et al., 2006; Yoshii et al., 2008). However, the association between computer work and CTS remains inconclusive, and the pathophysiological relationship between keyboard typing activity and CTS remains questionable. Furthermore, there is limited research on the median nerve at the wrist region among computer users.

The objective was to identify the changes in the
median nerve cross-sectional area (MNCSA) at dominant hand before and after keyboard typing activity.

2. Methods

Eight right-handed healthy male adults (age: 25.5 ± 2.3 years; height: 174.8 ± 3.0 cm; weight: 68.1 ± 9.0 kg) were recruited. Participants performed two typing activities at a computer workstation with a height-adjustable table and chair. The experiment involved a 30-minute rest followed by two 30-minute typing sessions. The ultrasound examination was performed prior to resting, before typing, and at the end of each typing session.

Participants sat upright with their forearm resting on a forearm support and at a table during the ultrasound examination. Ultrasound examination for the median nerve of dominant hand was performed using the GE Healthcare Ultrasound System (Model LOGIQ e) with a 6-13 MHz transducer (Model 12L-RS). A gel pad was used (thickness 7.0 mm; Sonar Pad, Nippon BXI Inc., Japan) as a coupling medium for the ultrasound examination.

The median nerve was examined at the proximal carpal tunnel at the pisiform bone level. Participants were instructed to relax their fingers during the ultrasound examination. Three ultrasound images were taken and the average of the three measurements was calculated. MNCSA was measured by a tracing method using ImageJ (Figure 1).

One-way repeated ANOVA was performed to examine the changes in MCNSA. Post-hoc pairwise Bonferroni-corrected comparisons were performed to examine the significant effects between conditions. The significance level was set at $\alpha = 0.05$. All statistical tests were performed using SPSS (Version 21, IBM, Japan). All results are presented as mean ± standard deviation.

3. Results

The MNCSA prior to rest, before typing, after 30-minutes of typing, and after 60-minutes of typing are 9.6 ± 1.7 mm$^2$, 9.4 ± 1.8 mm$^2$, 10.7 ± 1.9 mm$^2$, and 10.2 ± 1.2 mm$^2$, respectively (Figure 2). The main effect of the typing activity on the changes of MNCSA was significant ($p < 0.05$). The MNCSA at rest and before typing showed no significant difference. In contrast, the MNCSA became larger after the typing activity. For instance, the MNCSA became significantly larger after 30-minutes of typing compared to its measurement prior to rest and before typing.

4. Discussion

This study demonstrated the acute changes in the median nerve after keyboard typing activities by using MNCSA measurement. In comparison to the period prior to rest, the increased MNCSA after typing may indicate acute swelling of the median nerve. Previous studies observed a higher shear force over a long duration of single and multiple finger flexion movements (merged). Therefore, repetitive finger movements during keyboard typing could result in a higher friction among the subsynovial connective tissues, flexor tendons, and the median nerve. Consequently, it may lead to an enlargement of the MNCSA after 30-minutes and 60-minutes of typing.
Previous studies revealed physical work might result in inflammation of the neural tissues and changes in the cross-sectional area (Barbe et al., 2013; Roll et al., 2013). However, the underlying factors that cause the acute swelling of the median nerve after prolonged wrist-finger tasks and high intensity work remain unclear. Further investigation on the occupational biomechanical factors related to a typing activity, such as workstation design, fingertip loading, and the work-rest cycle is required to provide a more comprehensive understanding of the CTS pathophysiology.

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References


